Center Independent Research & Development: SSC IRAD

Batch Fabricated Multifunctional Thermal Sensors for high Temperature Propulsion Testing Environments

Completed Technology Project (2015 - 2016)

Project Introduction

Accurate measurements of temperature, heat flux, and thermal gradients are essential to rocket propulsion testing. Such data provides important insights to engineers that influence both near-term operational decisions and long-term developmental priorities. However, the associated harsh environments and high temperatures are not suitable for the vast majority of existing thermal instrumentation. Besides being able to function under extremely challenging test conditions, the ideal sensing solution should be able to obtain thermal characterization data while being both non-intrusive and cost effective.

The objective of this work is to design, fabricate, and characterize a multifunctional thermal sensor for high temperature environments suitable for use in rocket propulsion testing. Besides being able to provide accurate and repeatable data, the sensor will be designed to utilize low cost materials, be batch fabrication-compatible, and remain unobtrusive to flow or test operation during use. To achieve this, microfabricated thin film thermocouples and thermopiles of select refractory metals will be strategically integrated onto high-temperature ceramic substrates. The thermocouple features provide sensor temperature directly, while the thermopiles are used to measure heat flux normal to the substrate.

Anticipated Benefits

The sensor is based on the strategic integration of high temperature-compatible thin film thermocouples and thermopiles onto ceramic substrates using industry-standard microfabrication processes. This approach allows for batch-fabrication of small, low profile, low cost sensors which can be utilized across a wide variety of components and environments without significantly disrupting heat flow or operation. The thermocouple/thermopile features will be designed to provide both surface temperature and surface heat flux data simultaneously. When multiple such sensors are placed at various locations on a component of interest, temperature gradient information may also be obtained with millimeter-scale resolution. Unlike previous studies on the use of thin film thermocouples for high temperature applications, this project seeks to develop a robust thermomechanical design with integrated surface patterning to minimize thermally-induced stresses and prevent destructive cracking or delamination.

Technology Development Logo

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Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

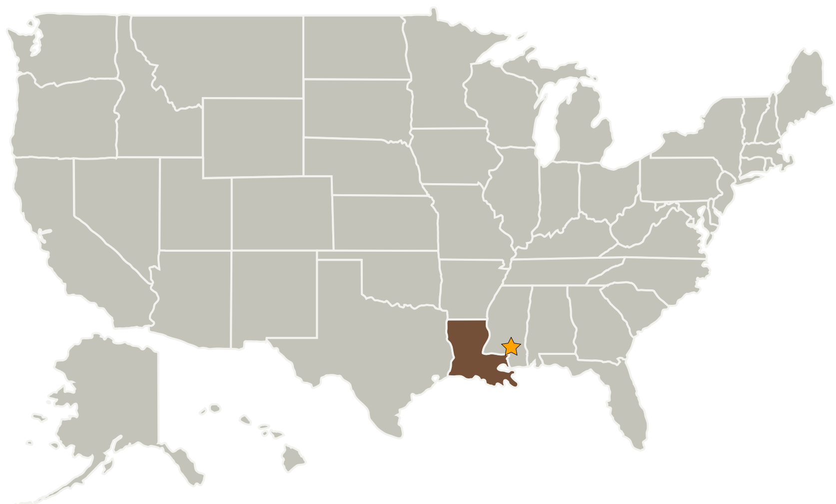
Lead Center / Facility:

Stennis Space Center (SSC)

Responsible Program:

Center Independent Research & Development: SSC IRAD

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Stennis Space Center(SSC)	Lead Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations
Louisiana

Project Management

Program Manager:

Ramona E Travis

Project Manager:

Curtis D Armstrong

Principal Investigator:

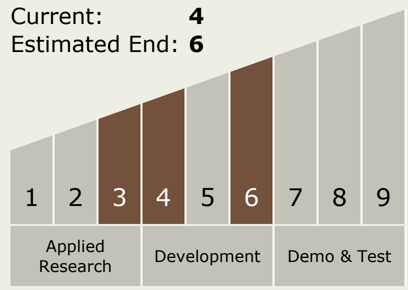
Dawn M Davis

Co-Investigator:

Arden Moore

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **6**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.3 In-Situ Instruments and Sensors
    └ TX08.3.6 Extreme Environments Related to Critical System Health Management

Images

Batch Fabricated Multifunctional Thermal Sensors for High Temperature Propulsion Testing Environments
Technology Development Logo
(https://techport.nasa.gov/image/19217)

Target Destination

Earth